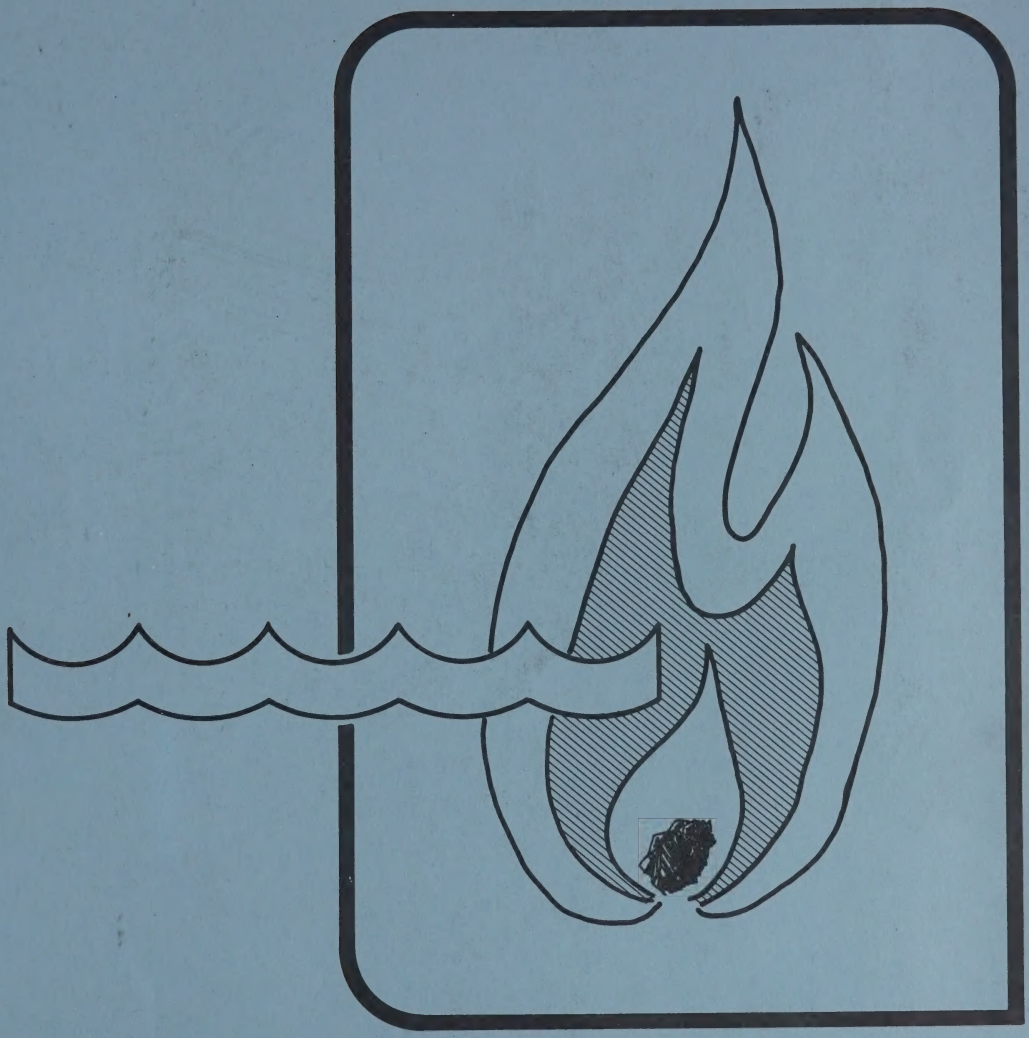

water for coal-energy development

MONTANA STATE OFFICE
BUREAU OF LAND MANAGEMENT

Montana State Office
Bureau of Land Management

May 19, 1975

WATER FOR COAL-ENERGY DEVELOPMENT

I. Introduction

Water is integrally related to coal-energy development. Water for energy development will be constrained by a number of legal factors including State water rights, interstate water compacts, Indian water rights, federally reserved water rights, and environmental law. Use of water for energy development will depend largely on whether water can be appropriated after allocations are made to existing water uses like municipal, industrial, agricultural, livestock, recreation, etc.

This paper is meant to present a basic understanding to the "water for energy" situation. It is suggested that the Report on Water for Energy in the Northern Great Plains Area with Emphasis on the Yellowstone River Basin by U.S. Department of Interior Water for Energy Management Team and the Northern Great Plains Resources Program, Report of the Work Group on Water be consulted for further details of the intricacies and complexities of the "water for energy" picture. This paper is a summary of those two reports and draws important facts from the reports.

The Report on Water for Energy in the Northern Great Plains Area with Emphasis on the Yellowstone River Basin is an analysis which was prepared by the Department of Interior's Denver-based Management Team. The Management Team was organized under the Assistant Secretary for Land and Water Resources, Jack O. Horton. This report serves as an important guideline for determining future policy on energy water issues and for providing factual bases for Secretarial decisions on water aspects of energy development.

Water is essential to all phases of energy development from mining and revegetation of mined lands to actual energy production, gasification, or other uses.

The Northern Great Plains Area, encompassing 63 counties in Montana, North Dakota and South Dakota and Wyoming, is generally within the Upper Missouri River Basin. The boundaries of the Area and the Basin are shown on Figure 1. The Upper Missouri River Basin and the Northern Great Plains Area represent the states under the jurisdiction of the BLM's Montana State Office with the exception of Wyoming.

II. Legal Framework

Energy development in the Northern Great Plains Area will be dependent upon the right to obtain and utilize water. Historically, developers of energy and other mineral resources have provided their own water supplies for such development.

This is further emphasized in proposed Departmental policy - "Water Resources; Use and Management" in which non-Federal entities shall develop a water management program for effective and efficient use of water in resource development. It is assumed that non-Federal entities will be responsible for obtaining leases, permits or other rights to develop Federal energy resources. Such entities, under current policy, will be expected to obtain the water necessary for development of such resources under State procedures unless water is available from Federal storage. The Department of Army, Corps of Engineers, and the Department of Interior, Bureau of Reclamation, have recently entered into a Memorandum of Understanding concerning sales of stored water from the Missouri main stem reservoirs.

A. State Water Rights

To aid in understanding States' Water Rights, refer to Table I. Table I gives information as to type of water rights law, the water rights administration, types of beneficial uses recognized for water allocations and the definition of beneficial use for the three states under the Montana State Office jurisdiction.

In all three states the Doctrine of Prior Appropriation is recognized. It predicates that "first in time is first in right" and streams are adjudicated on that basis. Issuance of a permit is for the use of the water only, rather than ownership; ownership resides in the public.

In contrast, under the Riparian Doctrine, the owner of land contiguous to a natural stream or natural lake may use the waters for such purposes and in such quantities as he chooses, as long as he does not appreciably diminish the flow or impair the quality of water for downstream uses.

Under the Appropriation Rights Doctrine, the beneficial use of water provides the basis for determining the measure and the limitations of the water right.

B. Instream Flow

One beneficial use recognized in Montana by statute and not in North or South Dakota is instream flow. It is the amount of water needed for fisheries and wildlife, recreation, and esthetic purposes. However, other purposes may be of equal or of greater concern in certain stream reaches (maintenance of the stream associated ecosystem, fur-bearer management, wilderness preservation, etc.). With rapidly increasing demands for water, it is imperative to determine the preliminary minimum instream water requirements needed to maintain physical, chemical, and biological conditions necessary to sustain aquatic communities (including fish populations and riparian habitats).

However, "instream flows" is a concept not widely recognized in the water laws of western states, and whether its legality can be sustained in the courts is yet to be tested. The legality of an appropriation for "instream needs" cannot now be questioned in Montana. The Montana Water Use Act of 1972 provides that recreation, fish and wildlife, etc., are beneficial uses. The only area open to question is whether the quantity of water appropriated or reserved for instream needs is reasonable.

C. Interstate Compacts

There are only two interstate river compacts in the Montana State Office area of jurisdiction -- the Yellowstone River Compact and the Belle Fourche River Compact.

The Yellowstone River Compact, among Montana, North Dakota and Wyoming, was approved by the Act of October 30, 1951, (65 Stat. 663). Article V(B) of the Compact confirms existing rights as of January 1, 1950, provides the opportunity for existing rights to obtain supplemental water, and apportions the waters of the tributaries of the Yellowstone River, which were unappropriated on January 1, 1950, between Montana and Wyoming as follows:

Tributary	Montana (percent)	Wyoming (percent)
Clarks Fork	40	60
Bighorn	20	80
Tongue	60	40
Powder	58	42

The Compact authorizes diversion and impoundment in one state for use in another state pursuant to the laws of the state involved in Article VII. Article X prohibits diversion of water out of the Yellowstone subbasins except upon unanimous consent of the compacting states. Article X also provides for the import of water to the Yellowstone subbasin with due credit being given to the importing state. Article VI provides that the Compact shall not adversely affect Indian rights. The Compact also provides that tributaries arising entirely within a state are subject to disposition within that state. The Compact allocates the waters of the interstate tributaries of the Yellowstone River between Montana and Wyoming as shown above. There are no interstate tributaries in North Dakota; consequently no water allocation is made to North Dakota. The Compact does, however, confirm existing rights in North Dakota and grant to North Dakota the other opportunities of the Compact, such as developing water in an upstream state and so on.

The Belle Fourche Compact apportioned the unappropriated water, as of February 26, 1944, of the Belle Fourche River between Wyoming (10 percent) and South Dakota (90 percent) and was approved by the Act of February 26, 1944, (58 Stat. 94).

Existing rights were recognized between the states and diversions and impoundments in one state for use in another state were authorized in accordance with state law.

D. Indian Rights

Among the most important duties of the Secretary of Interior are his trusteeship responsibilities for the Indian Tribes. There are Indian reservations in each of the Northern Great Plains Area States.

In recent years, Indian tribes generally have asserted numerous claims to the use of water throughout the West. Indian water rights arise under Federal law in accordance with the Indian reserved rights doctrine first recognized in Winters v. United States 207 U.S. 564 (1908). In nearly all cases such water rights came into being when a reservation was created whether by treaty, by Act of Congress, or by Executive Order and are geographically related to lands within the reservation. Some Indian Tribes are asserting water rights in addition to those rights based upon treaties, etc. There are several pending proposals for the assertion of such claims in the basin by several tribes. These potential claims have not been quantified. It must, therefore, be kept in mind that these potential Indian water rights claims have not been considered except as noted.

The question of Indian rights and the quantification of Indian requirements in the Northern Great Plains Area is currently under review by the Department of the Interior and the affected tribes. Lawsuits have been filed in Montana Federal District Courts to determine the extent of Indian reserved water rights and other federally reserved rights on streams relating to the Northern Cheyenne and Crow Indian Reservations. U. S. v. Tongue River Water Users Association, et. al., Civil No. 75-20-Blg. (Northern Cheyenne); U.S. v. Bighorn Low Line Canal Co., et. al., Civil No. 75-34-Blg. (Crow).

E. Federal Uses

There are consumptive uses presently being made by Federal agencies in the basin, such as Fish and Wildlife Service (hatcheries, refuges, etc.); Forest Service and National Park Service (campgrounds, etc.); and, Bureau of Land Management national resource uses.

F. Federal Responsibilities

One of the major Federal responsibilities in any significant program is compliance with the National Environmental Policy Act (42 U.S.C. §§ 4321 et seq. (1970)). The Department will be required to fully comply with this Act in considering Federal actions (leases, permits, rights-of-way, etc.), including preparation of necessary environmental assessments and impact statements.

The Secretary has important duties under the National Wild and Scenic Rivers System Act (16 U.S.C. §§ 1271 et seq.). The following rivers have been identified for possible designation as wild, scenic and recreation rivers: The Madison River in Montana from Quake lake to Ennis Lake; the Yellowstone River in Montana from Yellowstone National Park to Pompeys Pillar; the Wind River in Wyoming from its source to Boysen Reservoir; and the Little Missouri in North Dakota from Marmarth, North Dakota to Garrison Reservoir (Lake Sakakawea). If and when there are additions to the Wild and Scenic Rivers System in the states, it may be necessary to give consideration to the establishment of rights incident thereto. In the short time available it was not possible to quantify the potential claims of the United States in this respect as to the involved states.

Under the provisions of the Endangered Species Act of 1973 (P.L. 93-205), the Secretary (and all other Federal departments) is required to provide for conservation of endangered species and to utilize existing authorities to conserve endangered and threatened species and to take no actions to jeopardize existence of such species. Accordingly, these responsibilities are important considerations in those areas where endangered species are dependent on sufficient water supplies.

The Fish and Wildlife Coordination Act (16 U.S.C. §§ 661 et seq. (1970)), in Section 2(a), requires Federal agencies constructing, permitting or licensing projects which impound, divert or otherwise modify water bodies to consult with the Fish and Wildlife Service with a view to preventing losses or damages to fish and wildlife "in connection with such water resource development." Section 2(b) requires that the Secretary prepare reports on such

projects based on Fish and Wildlife Service findings and make recommendations in support of fish and wildlife conservation. The Act provides that the project plan "shall include such justifiable means and measures for wildlife purposes as the reporting agency finds should be adopted . . . ." The Coordination Act provides authority for and requires that reasonable steps be taken to protect fish and wildlife resources, including the use of conditions in Federal permits, easements or licenses.

While the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1215 et seq.; 86 Stat. 816) require the Administrator of the Environmental Protection Agency to regulate effluent discharges and certain other activities affecting water quality to prevent pollution of waters of the United States, other Federal administrators are obligated to give consideration to this requirement in Federal programs and at Federal facilities.

Section 10 of the Act of March 3, 1899 (33 U.S.C. § 403: 30 Stat. 1151) requires a permit from the Secretary of the Army before diversion facilities are constructed in the bed of a navigable stream. Such a Section 10 permit, or other Congressional authorization, may also be required before any substantial quantity of water is diverted from a navigable stream. Sanitary Dist. of Chicago v. United States, 266 U.S. 405, 428-30 (1924).

Some possible constraints upon the use of water from Federal reservoirs for energy development are as follows:

The Miscellaneous Water Act of 1920 (43 U.S.C. § 521; 41 Stat. 451) limits the use of Municipal and Industrial water from a Reclamation single-purpose irrigation project to uses: (1) which cannot be practically served from another source; (2) which are approved by the project irrigators; and (3) which are not detrimental to irrigation use.

Section 9(c) of the Reclamation Project Act of 1939 (43 U.S.C, § 485 (h)(c); 53 Stat. 1187) limits the use of Municipal and Industrial water from a conventional Reclamation project to uses which will not impair the efficiency of the project for irrigation purposes.

Title III of the Water Supply Act of 1958 (43 U.S.C. § 390(b); 72 Stat. 320) limits the use of Municipal and Industrial water provided under this Act to situations: (1) where an allocation of costs to the Municipal and Industrial purpose has been made; and, (2) where Congressional approval has been secured for any operational changes which would seriously affect the purposes for which the project was originally authorized.

The National Historic Preservation Act of 1966, 16 U.S.C. § 470, the Historic Sites Act of 1935, 16 U.S.C, §§ 461-467, the Act of June 27, 1960, U.S.C. § 469, the Antiquities Act of 1906, 16 U.S.C. §§ 431-433, and Executive Order No. 11593 of May 13, 1971, 36 F.R. 8921, require archeological surveys of Federal programs or federally financed programs prior to the commencement of construction.

III. Water Supply

The total unallocated water supply in the Upper Missouri River basin appears to be ample, through year 2000, to meet all projected needs and uses including a high degree of energy development. However, in the Yellowstone subbasin and particularly in the Bighorn River drainage of that subbasin there is a problem of distribution of supply from point of origin to point of potential need. Within the Bighorn River drainage there will be competition of water use between instream flow uses and future consumptive uses if the needs of this area materialize as projected in this report. Most of the uses and projections, however, are based on very minimal studies and need detailed evaluations and support before a definite conclusion on water availability and adequacy can be reached. Even the more definitive projections concerning energy development are so dependent on production processes and technology that actual water requirements can vary considerably from present estimates. Instream flow needs must be carefully evaluated and supported through detailed field studies, since they could be the major constraint on diversions for most consumptive uses.

A. The average annual flow of the Missouri River at Sioux City, based on an analysis of the historic period of record is 28,353,000 acre-feet. The 1970 level of depletion is estimated to be 6,532,000 acre-feet. This results in an average annual

flow of 21,821,000 acre-feet available as of 1970. Of this amount, the average annual flow of the Yellowstone River, a major tributary of the Missouri, is 8,800,000 acre-feet. These flows are the result of regulation by several large storage reservoirs. Authorized projects in the upper basin, outside the Yellowstone, consisting of the Garrison, Oahe and O'Neil Units, when constructed, will consume 1,297,000 acre-feet of these available supplies.

The quality of the surface water in the basin is generally good. However, the quality of some tributaries may be locally poor until their flows blend downstream with flows of better quality. Generally, the surface water is satisfactory for present use.

B. Ground Water

Ground water may be available in areas of current and planned coal-energy development in quantities sufficient for supplemental supply or as a sole source of supply on a modest scale and time-limited basis. The shallow sources consist of a series of sandstone formations and coal beds to a depth as great as 5,000 feet which can yield as much as 500 gal/min to individual wells. Most existing wells in this series are less than 300 feet in depth; however, long-term supply wells from this source would generally be 1,000 to 5,000 feet in depth. A deeper and relatively unexplored source is the Madison formation, ranging in depth from land surface in the margins of the Powder River basin to about 15,000 feet below land surface in the southern part of the basin. Geohydrologic conditions are favorable locally for production of a few hundred to a few thousand gallons per minute from individual wells in the Madison formation. Considerations in regard to ground water, other than as a source of supply, include effects of large-scale withdrawal and lowering of water levels on streamflow and vegetation, and effects of strip mining and leachates from mine spoils on the quality of ground water. The quality of the shallow ground water ranges from about 1,000 mg/l to about 5,000 mg/l compared to standard of total dissolved solids. The quality of deeper ground water from the Madison formation is thought to range from about 1,000 to 2,000 mg/l in northeastern Wyoming and southeastern Montana; but exceeds 100,000 mg/l in western North Dakota.

IV. Water Uses in Coal Development

Coal development would result by various types of water use such as mining use, transportation of coal via slurry line, use by coal-fired thermal electric production, gasification of coal, liquefaction of coal, production of fertilizer and rehabilitation. Table 2 shows expected water requirements for those types of operations. It should be noted that these are the best estimates at the present time for some standard levels of production. These estimates are subject to fluctuation based on the technologies available. In determining the most probable level of development and the extensive level of development, the Water for Energy Management Team considered mainly coal-fired electric powerplants and coal gasification plants in their projection because these are expected to be the major user of water in future coal development.

The estimated coal production in the Northern Great Plains Area and related water requirements are shown below. The extensive coal development alternative is based on expanded use of coal for export and coal gasification. This uses less water per ton of coal than thermal electric power generation which is the major water use in the most probable level of development. Extensive use of air cooling for both thermal electric plants and synthetic gas plants would have a major impact on reducing water requirements.

Estimated Coal Production and Related Water

Requirements For The Year 2000

	Upper Missouri Basin		Yellowstone Subbasin[1]	
	Most Probable	Extensive	Most Probable	Extensive
Coal Production (million tons/year)	363	1,000	205	721
Water Requirements (1,000 acre-feet/year)				
Mining and processing	596	1,066	257	586
Revegetation	18	41	10	30
TOTAL	614	1,107	267	616

1 Included in Upper Missouri Basin

The above estimates can change considerably as the Nation's energy policy evolves. The attitudes of the States and the Indian tribes in encouraging or discouraging coal production can greatly influence energy development in each state. As an example, Montana's concern for the adverse environmental impacts of coal development could result in a higher level of development in other states. Many other factors such as: (1) competitiveness of coal produced in other areas; (2) development of alternative sources of energy; (3) air quality standards; and, (4) the success of energy conservation efforts all can have a major effect on coal and energy production in the Northern Great Plains Area.

There are many other water requirements and uses which must also be considered and planned for. These include municipal, other industrial, agricultural, and environmental water needs. Future additional municipal and industrial needs, including that related to the municipal part of energy development, are estimated at 315,000 acre-feet by year 2000 for the Upper Missouri River basin which includes 130,000 acre-feet for the Yellowstone subbasin. Future additional agriculture water requirements,

consisting primarily of irrigation, are estimated to range upward to 1,910,000 acre-feet annually in the Upper Missouri River Basin including 540,000 acre-feet annually for the Yellowstone Subbasin. These amounts, however, could vary significantly depending on such uncertainties as national food import and export policies, price supports, federal subsidies for irrigation and climatic conditions. Additional water requirements for the management of Bureau of Land Management administered lands in the Upper Missouri River Basin are estimated at 52,000 acre-feet including about 9,000 acre-feet in the Yellowstone Subbasin. Future consumptive use of water for environmental purposes such as recreation, water quality, and esthetics are very important within the basin, but are difficult to assess in quantitative terms. However, future consumptive water requirements for fish and wildlife have been tentatively estimated at 630,000 acre-feet annually for the Upper Missouri River Basin including 53,000 acre-feet for the Yellowstone Subbasin. The water supply and projected consumptive needs for the year 2000 are shown as follows:

	UMR Basin (Acre-feet)	Yellowstone Subbasin* (Acre-feet)
Water Supply		
Estimated undepleted flow	28,353,000	11,235,000
Total Depletions (1970)	6,532,000	2,435,000
Water available 1970	21,821,000	8,800,000
Projected needs (2000)		
Energy (including revegetation)	614,000 to 1,107,000	267,000 to 616,000
Municipal & Industrial	315,000	130,000
Irrigation	1,910,000	540,000
Other uses	630,000	53,000
BLM Lands	52,000	9,000
TOTAL PROJECTED NEEDS	4,014,000	1,348,000
Water available (2000)	17,807,000	7,452,000

*Included in UMR Basin

Note: The above projections do not fully reflect Indian development aspirations.

Estimates of supplies versus demands are shown graphically in Tables 3 & 4, respectively, for the Upper Missouri River Basin and the Yellowstone Subbasin.

In addition to the consumptive use needs above, which usually require diversion from the streams, there are numberous instream flow needs such as hydropower, fish and wildlife, recreation, water quality and esthetics. Instream flows for hydropower are generally based on opportunities from the overall operation plan. Instream flows for the environmental needs have been determined at critical points in the Yellowstone Subbasin. These needs would require the bypass of 1,527,000 acre-feet annually at the mouth of the Bighorn where the average annual flow is 2,550,000 acre-feet and 4,217,000 acre-feet at Miles City on the Yellowstone River where the average annual flow amounts to 7,740,000 acre-feet. Accretions and return flows increase the flow of the main stem Yellowstone below Miles City to a level where most instream flow requirements could be met under the proposed ranges of development. It is evident that there will be competition for water use between the instream flows and the consumptive uses itemized above. Any plan to provide for both these uses would probably require additional storage and regulation of the water supply. Within the scope of this study, however, it was not possible to analyze the availability of water at specific points throughout the basin to meet both instream flow requirements and diversion for irrigation and energy uses. Preliminary studies do show, however, that if diversions for consumptive requirements used in this report were provided, significant progress toward meeting instream flow requirements could still be met. Furthermore, the farther downstream major diversions for energy are made, the less impact such diversion will have on instream flows throughout the basin. There are, therefore, opportunities for trade offs between cost of diversion and the loss of free-flowing stream values. Diversion from the vicinity of Miles City, Montana, the farthest feasible downstream point, would have the least impact on instream values throughout the basin.

Under Montana law, instream flows are recognized as beneficial use and subject to appropriation under State law. The Montana Department of Fish and Game has made application for the reservation of 7,100,000 acre-feet of instream flows in the Yellowstone River.

Should Wyoming deplete its legal entitlement under the Yellowstone Compact, Montana could expect less than 510,000 acre-feet at the Wyoming-Montana State line, on the Wind River-Bighorn drainage system, in an average year. This would result in serious shortages not only to instream flows but to most projected water uses in Montana.

There are waters and opportunities that will satisfy a considerable portion of future recreation demand in the basin, but several limiting factors must first be eliminated. Among the most significant is the need to provide more and better quality access to the reservoirs and streams in the basin. As recreation use of these resources becomes greater, their quality will need to be protected through well-planned and managed recreation facilities. To alleviate these factors it will be necessary to secure more incentive, interest and funding for development, operation and maintenance of recreation facilities. A potential exists for several streams in the basin to be designated in the future as wild and scenic rivers. Such designation could constrain future impoundments, withdrawals and riparian land uses and would have to be accommodated in development plans.

V. Recommendations

The Report on Water for Energy in the Northern Great Plains Area with emphasis on the Yellowstone River Basin summarized their analysis by recommending the following proposed actions:

FEDERAL

1. Explore the ground water aquifers to provide a more detailed evaluation of the availability and quality of the water in storage.

2. Establish pilot weather modification programs to determine the possibility for augmentation of the water supplies in the Yellowstone Subbasin.

3. Quantify Federal water requirements and encourage the maximum practical efficiency of water use in all Federal land leases, Federal water contracts and Federal resource developments.

4. Perform a level B grade investigation in Yellowstone Subbasin to fill in gaps in existing data, particularly in the environmental areas.

5. Implement detailed level C studies of the Yellowstone Subbasin under current principles and standards for water resources investigations to better define its water needs and water-supply systems and to stay abreast of the fast moving energy development picture.

6. Accelerate studies of potential wild and scenic segments of the Yellowstone system.

7. Continue intensive coal research and technology activities to better define conversion processes and cooling techniques to minimize water requirements.

STATES

1. Complete their State water plans as soon as possible.

2. Develop a policy position on energy development in full recognition of other water requirements.

3. Work with Federal agencies to complete instream flow requirement studies in the Yellowstone basin.

4. Exert strong leadership in the resolution of water rights and water allocation actions and in the attainment of more efficient water use.

With such actions on the part of the State and Federal governments, sufficient coal resources can be developed in the Northern Great Plains Area to provide a significant contribution to the Nation's energy needs.

VI. Sources

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U.S. Dept. of Interior, Water for Energy Management Team, Report on Water for Energy in the Northern Great Plains Area with Emphasis on the Yellowstone River Basin, January 1975.

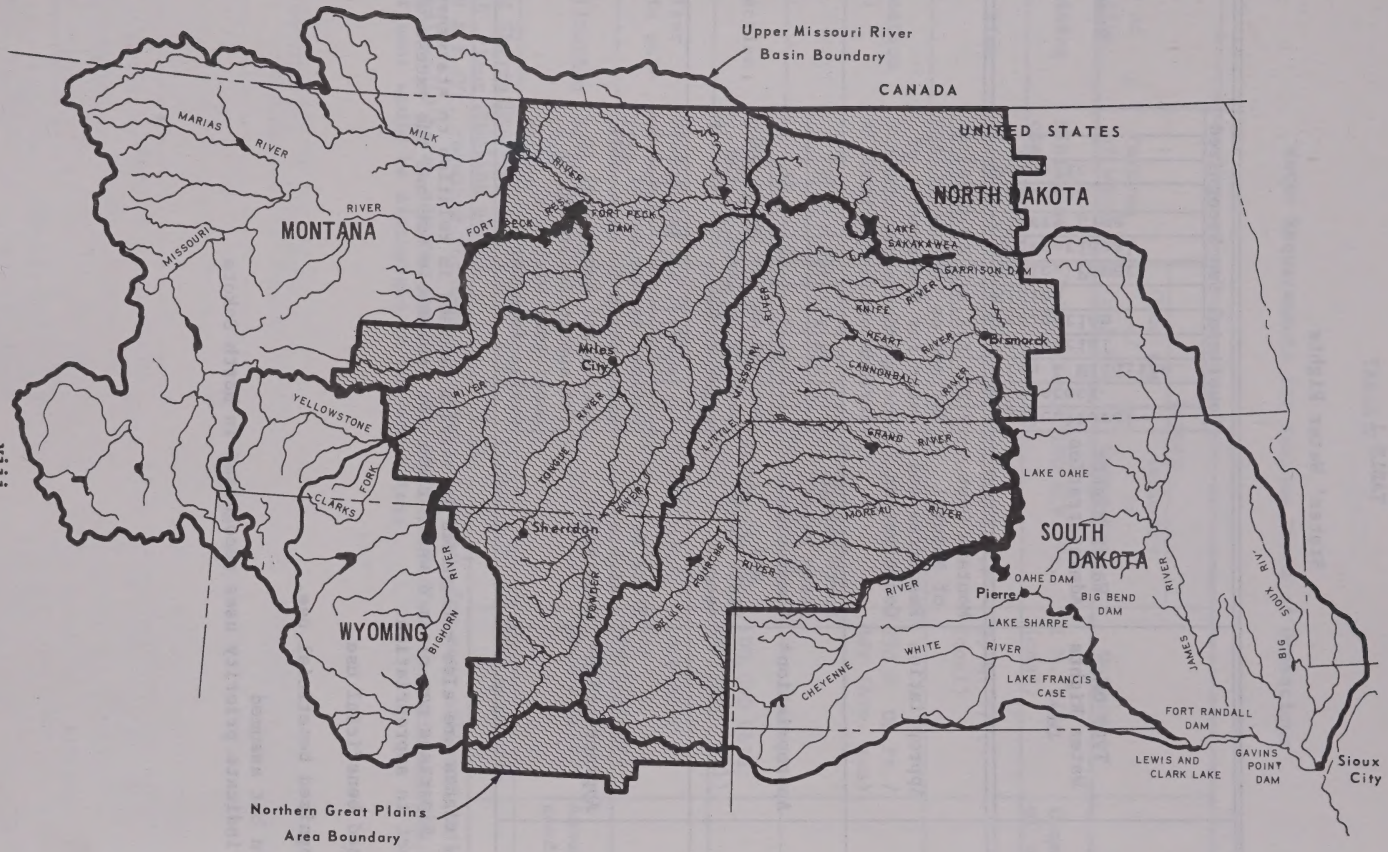


Figure 1. Study Area - Northern Great Plains

TABLE 1

States' Water Rights

States	Type of Water Rights Law	Water Rights Administration	Beneficial Use Recognized													Remarks
			Agricultural	Livestock	Fish & Wildlife	Industrial	Irrigation	Mining	Munic. Power	Recreational	Slurry Line	Instream	Domestic			
Montana	Appropriation	Montana Dept. of Natural Resources and Conservation	X	X	X	X	X	X	X	X	0	X	?			
			Defined as the use of water for the benefit of the appropriator, other persons or the public.													
North Dakota	Appropriation*	North Dakota State Water Commission and State Engineer	?	X	X	X	X	?	?	X	?	0	X			
				2	5	4	3			5			1			
			Defined as the basis and measure or limit of the right to use.													
South Dakota	Appropriation*	State Water Rights Commission	?	?	?	?	?	?	?	?	?	0	?			
			Defined as any use of water which is reasonable, useful and beneficial to the appropriator and is consistent with the public interest.													

* Riparian rights are also recognized in varying degrees in relation to statutory rights. Riparians can claim a water right for reasonable use but the excess water is subject to appropriation.

X Recognized beneficial use.

0 Not recognized beneficial use.

? Not known but assumed
Numbers indicate priority uses recognized in North Dakota

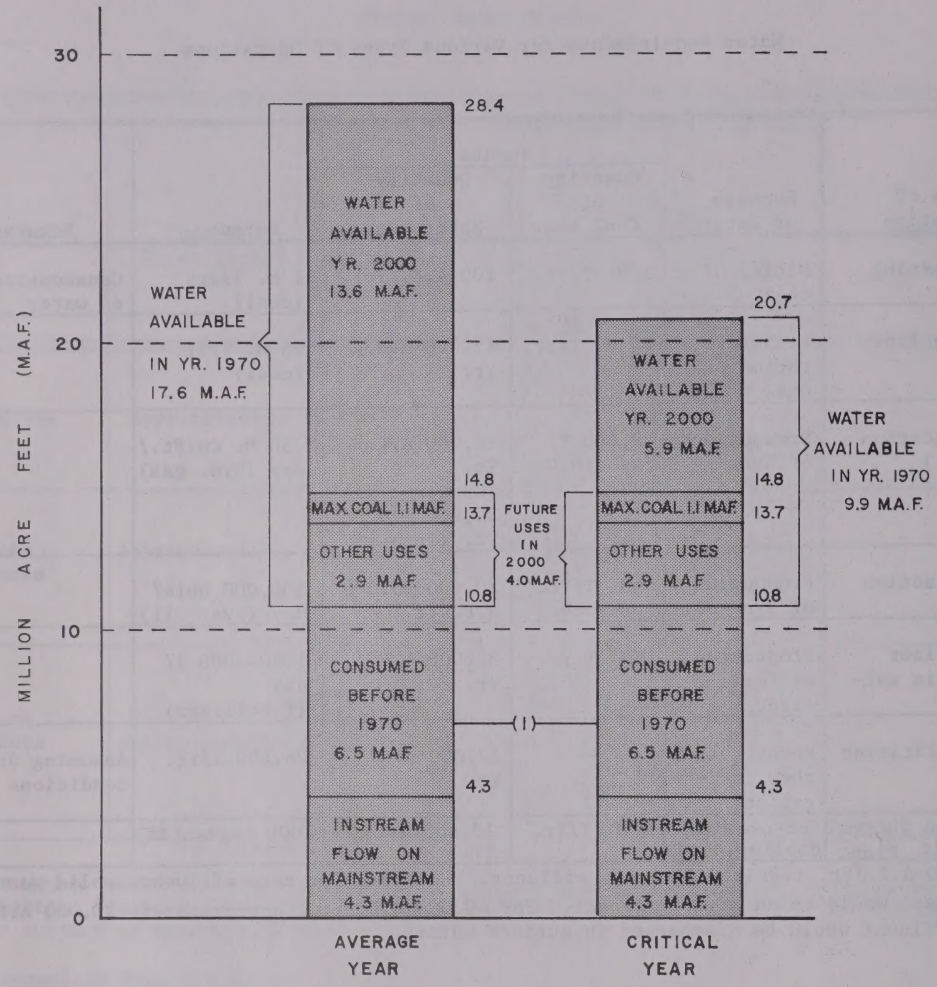
TABLE 2

Water Requirements for Various Types of Operations

Type of Operation	Purpose of Water	Inputs		Outputs	Remarks
		Quantity of Coal Req.	Quantity of Water Req.		
Coal mining	Mining of coal	1 M. T/Yr.	100 A.F./Yr.	1 M. T/Yr. (coal)	Consumptive use of water
Slurry line	transportation of coal	25 M. T/Yr.	15,000 A.F./Yr.	25 M. T/Yr. (coal)	
Gasification (Lurgi)	Production of Syn. gas	28,000 T/day (10.4 T/Yr.	10,000 A.F./Yr. (Consumptive) 30,000 A.F./Yr. (Total)*	250 M. Cu.Ft./day (Syn. gas)	
Liquefaction	Production of Syn. oil	5 M. T/Yr. (presumed)	20,000-25,000 A.F./Yr.	100,000 bbls/day (Syn. oil)	
tilizer (ammonia sulphate)	Production of fertilizer	1 M. T/Yr.	32,000 A.F./Yr.	1000-3000 T/day (fertilizer)	
Rehabilitation	Revegetation thru irrigation	--	17,000 A.F./Yr.	26,400 A/Yr.	Assuming drought conditions
Coal Fired Thermal Electric Plant	For use in cooling ponds	8 M. T/Yr.	19,000 A.F./Yr.	1000 megawatts	

*10,000 A.F./Yr. required for zero effluent. However, for zero effluent, solid waste disposal would be an adverse impact. For 30,000 A.F./Yr., approximately 20,000 A.F./Yr in effluent would be discharged in surface waters.

TABLE 3



UPPER MISSOURI BASIN AT SIOUX CITY

(1) INCLUDES 4.2 M.A.F. FOR FOOD FIBER, .9 M.A.F. FOR RESERVOIR EVAPORATION, AND .4 M.A.F. FOR OTHER USES.

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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CHECKED	APPROVED
SCALE	
DATE	SHEET OF
DRAWING NO.	

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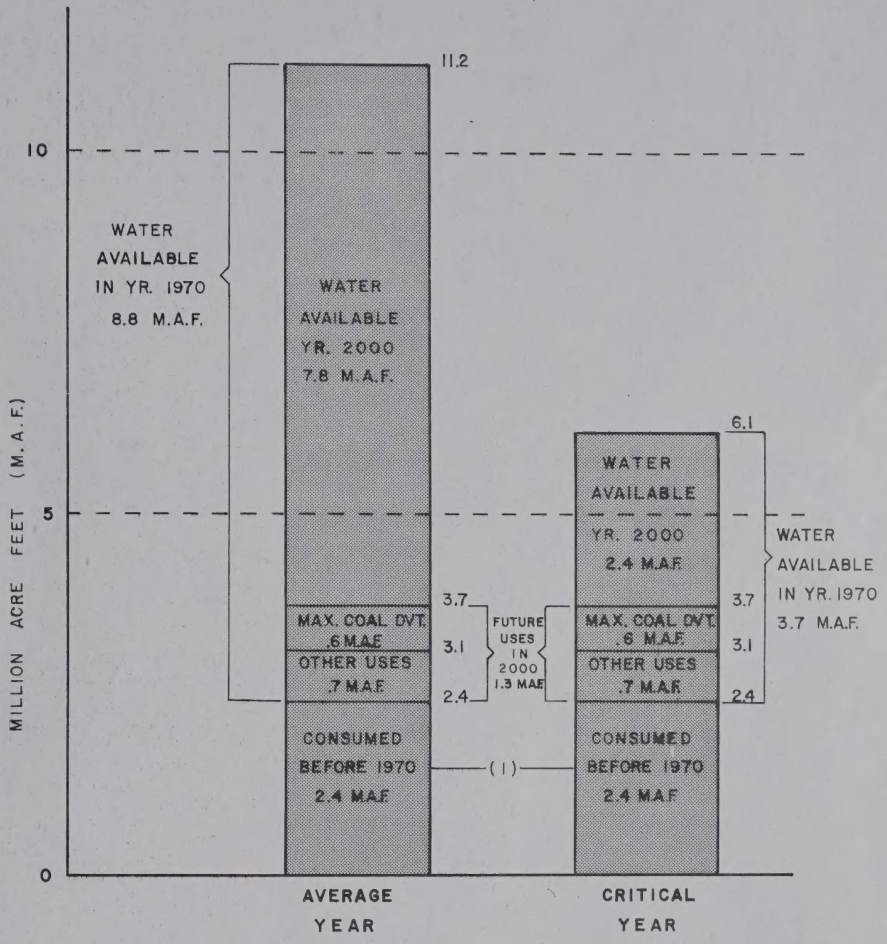
TABLE 4



YELLOWSTONE SUBBASIN (2)

(1.) INCLUDES 2.0 M.A.F. FOOD & FIBER, 0.3 M.A.F. FOR RESERVOIR EVAPORATION AND 0.1 M.A.F. FOR OTHER USES.

(2.) INCLUDED IN THE UPPER MISSOURI BASIN, NOTE THAT THE MONTANA DEPT. OF FISH & GAME MADE A REQUEST RESERVATION OF 7.1 M.A.F. IN THE YELLOWSTONE SUBBASIN & 2.4 M.A.F. IS WYOMING'S POSSIBLE SHARE IN THE YELLOWSTONE SUBBASIN IN AN AVERAGE YEAR. NEITHER ARE REFLECTED ABOVE.

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